Interplay of local moment order and superconductivity in RNi_2B_2C series.

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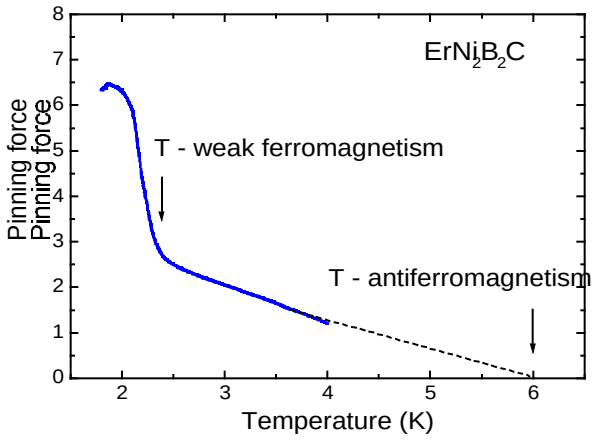
Upper figure: Single crystal of RNi_2B_2C and neutron diffraction pattern made by a square flux line lattice.

Lower figure: Pinning force vs. temperature for $ErNi_2B_2C$ (T_c=10K) - schematic



Superconductivity and local-moment magnetic order often occur in nature, but rarely together. The RNi_2B_2C (R = Gd - Lu, Y) series provides the opportunity to study these often antagonistic physical properties alone and together, depending upon the choice of rare earth, R [1]. Due to the availability of large, high quality single crystals, and the relatively high values of magnetic and superconducting ordering temperatures the RNi_2B_2C family has become the best studied series of magnetic superconductors.

High sample purity and non-cubic symmetry contribute to the observation of novel changes in the structure made by the filaments of magnetic field that pass through the sample in the superconducting state (the flux line lattice or FLL). The discovery of these novel geometries [1,2] has revitalized the study of the FLL in non-high-T_c superconductors (see upper fig.) and demonstrates quantum mechanical phenomenon giving rise to nanometer-scale structures.

Local moment ordering affects a number of the superconducting properties. Sudden changes in the superconducting upper critical field (H_{c2}) occur at the magnetic ordering temperature. Recent studies reveal that the sign of the change can be tuned [3] by the direction of the applied field. In addition, the superconducting critical current, and therefore pinning force, is found to increase dramatically upon entering into magnetically ordered states with small ferromagnetic components (lower fig.) [4]. In both of these cases the details of the magnetic order (specifically the wave vector) determine the effect on the superconducting properties.

During the past 6 years Ames Lab and collaborators have published over 100 papers (including 12 PRL, 2 Nature, 40 PRB) in this rapidly developing field.

References: [1] P. C. Canfield et al., *Physics Today* **51** (10), 40 (1998). [2] M. R. Eskildsen et al., *Nature* **393**, 242 (1998). [3] S. L. Bud'ko and P. C. Canfield, *Phys. Rev. B* **61**, R14932 (2000). [4] P. L. Gammel et al., *Phys. Rev. Lett.* **84**, 2497 (2000).